(12) UK Patent Application (19) GB (11) 2 080 452 A

(21) Application No 8122168
(22) Date of filing 17 Jul 1981
(30) Priority data
(31) 80/23339
(32) 17 Jul 1980
(33) United Kingdom (GB)
(43) Application published
3 Feb 1982
(51) INT CL³
F16H 37/08 // 11/06
(52) Domestic classification
F2D 2C2B3 2C2J1 2C2K1
2C4B2 2D5 2D7 A019
B040 C047
(56) Documents cited
GB 2010423A
GB 1454702
GB 1327968
GB 1137231
GB 1118260
GB 879157
(58) Field of search
F2D
(71) Applicant
John Warrender Franklin,
14 Daintree Croft,
Coventry CV3 5DN, West
Midlands
(72) Inventor
John Warrender Franklin
(74) Agents
Walford & Hardman
Brown,
Trinity House, Hales
Street, Coventry
CV1 1NP, West Midlands

(54) Variable speed gear box

(57) A variable speed gear box, particularly a hub gear box for a pedal cycle wheel, comprises a rotatable input member driving the planet carrier 14 of an epicyclic gear train having also an annular gear and a sun gear 10. The annular gear 9 is integral with or is attached to an output or driven member 1 rotatable relatively to the input or driving member 5. A variable ratio drive means 16 acts between the planet gear carrier 11 and the sun gear 10 of the epicyclic gear train and its ratio is adjusted between a value greater than unity and a value less than unity, thereby to vary the rotational speed of the output member. Where the gear box is a hub gear box of a pedal cycle, the input or driving member of the gear box is rotatable by the driven sprocket of the cycle, the output or driven member of the gear box is the housing of the gear box and the hub of the wheel and the variable ratio drive is changed by a cable 19 movable axially of the gear box and the wheel in one direction against the force of a return spring 23 by an angularly-oscillatable arm carrying an idler sprocket wheel engaging the driving run of the driving chain of a cycle, the arm being biased by spring means in a direction to maintain the driving run of the chain in tension.

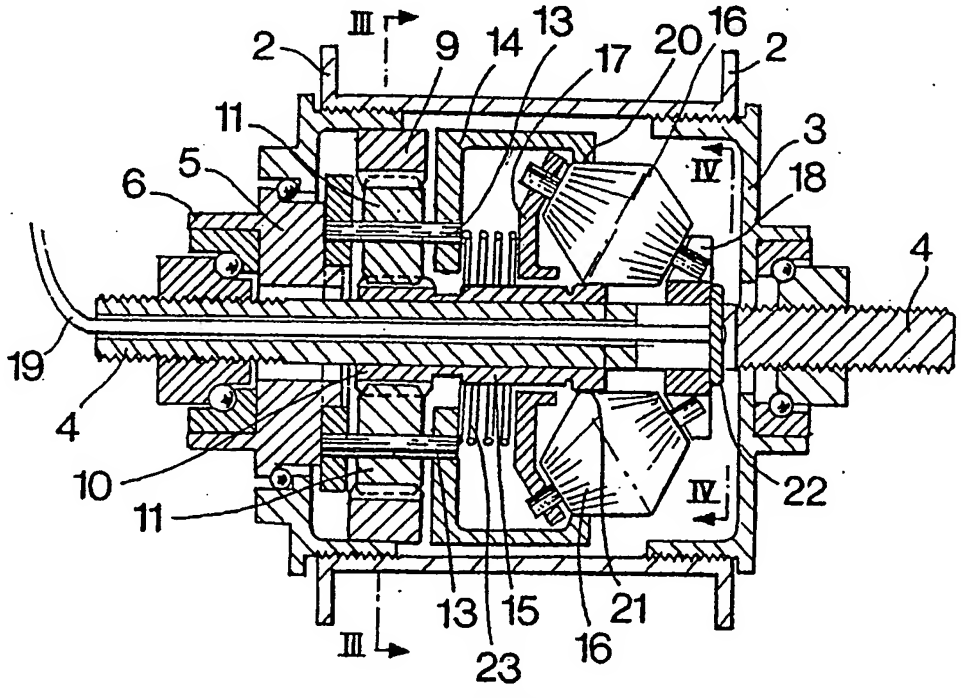


FIG.1

GB 2 080 452 A

2080452

1/2

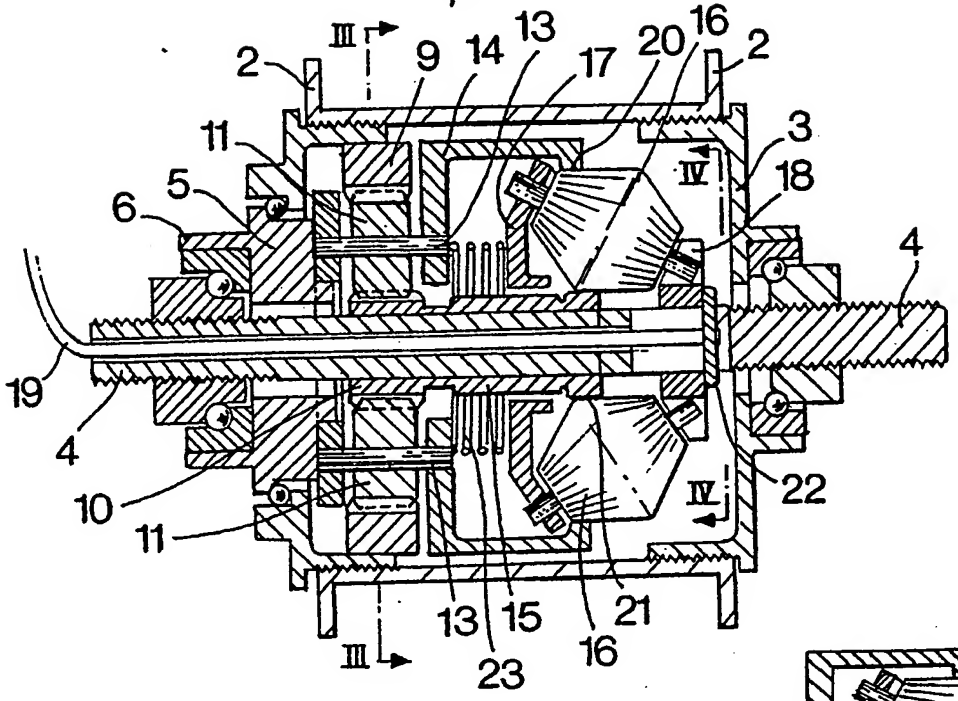


FIG.1

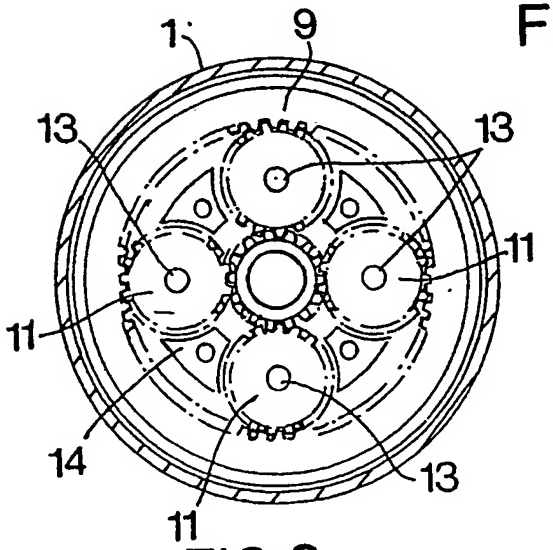


FIG.3

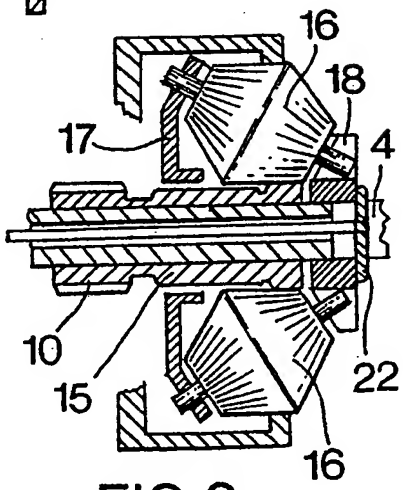
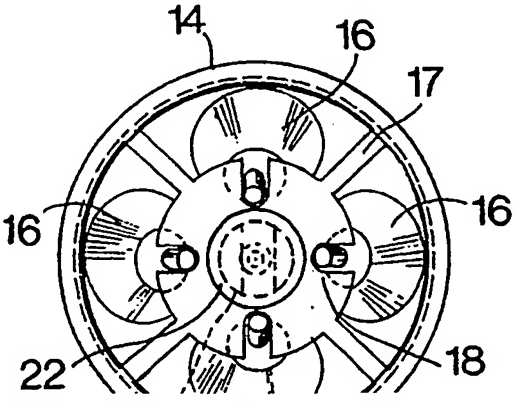


FIG.2



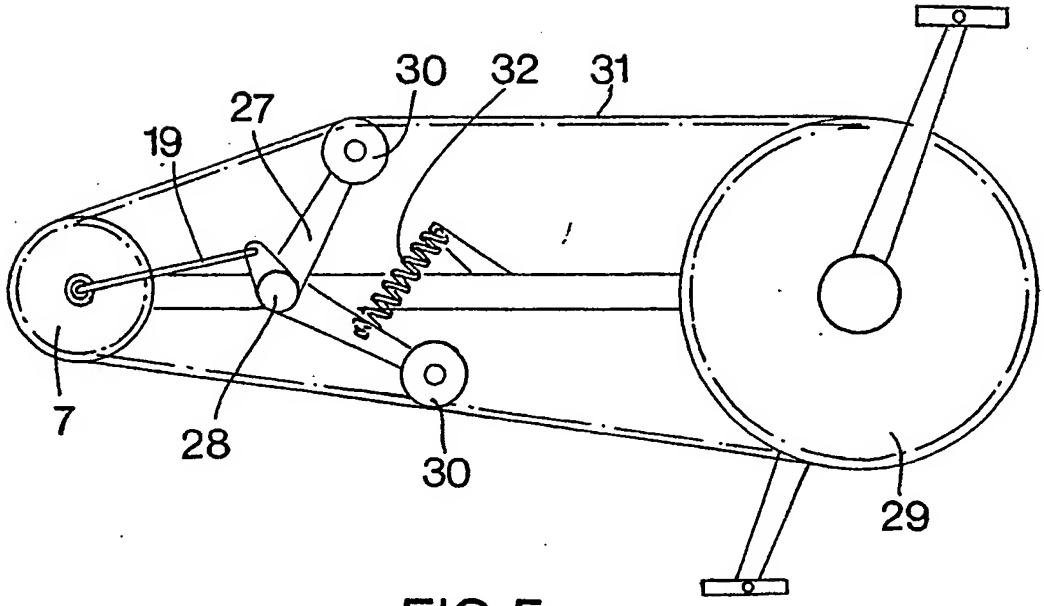


FIG.5

SPECIFICATION

Variable speed gear box

The invention relates to a variable speed gear box and is particularly, but not exclusively, concerned with a variable speed hub gear box of a bicycle.

An object of the invention is to provide a variable speed hub gear box by which the rotational speed of the output member thereof is automatically adjusted in accordance with the torque applied by the driving chain and thereby to eliminate or reduce the variation of tractive effort required during each revolution of the pedal sprocket. However, the gear box may have other applications where adjustment of the rotational speed of the output member of the gear box with respect to that of the input member is required.

According to the invention, a variable speed gear box comprises a rotatable input or driving member; an epicyclic gear train having an annular gear, a sun gear, a plurality of planet gears and a planet gear carrier, of which the planet gear carrier is rotatable about a common axis of the annular and sun gears and is integral with or is attached to the input member and the annular gear is integral with or is attached to an output or driven member rotatable relatively to the input or driving member, a variable ratio drive means acting between the planet gear carrier and a gear of the epicyclic gear train other than a planet gear, and means for adjusting the ratio of the variable ratio drive means between a value greater than unity, through unity, and a value less than unity, thereby to vary the rotational speed of the output member.

Conveniently, the variable ratio drive means acts between the planet gear carrier and the sun gear.

The variable ratio drive means may comprise a plurality of barrel-like members arranged in a ring around the common axis of rotation of the epicyclic gear train and each rotatable about an axis inclined to the common axis and bodily slidable along said common axis, the peripheral surfaces of the barrel-like members being engaged by a pair of annular followers carried by the sun gear and the planet gear carrier respectively, whereby rotational drive is effected on rotation of the input or driving member between the planet gear carrier, the follower carrier thereby, the barrel-like members, the follower carried by the sun wheel and the sun wheel, the ratio of the drive depending upon the ratio of the effective distances from said common axis of the points of contact of the respective followers with the barrel-like members according to the instantaneous axial positions of the latter relative to the sun wheel.

The barrel-like members may each be in the form of a pair of frustums of a cone arranged co-axially of each other with their larger diameter end faces abutting, thereby to form a member which in axial cross-section is of hexagonal shape.

The barrel-like members are conveniently mounted in a cage which is movable along said common axis by an adjusting member.

In one particular application, the variable speed gear box as set out in the immediately preceding paragraph is a hub gear box of a bicycle, or other pedal cycle, said common axis being the axis of rotation of a driven wheel of the cycle, the input or driving member of the gear box being rotatable by the driven sprocket of the cycle, the output or driven member of the gear box being the housing of the gear box and the hub of the wheel, the common adjusting member being movable axially of the gear box and the wheel in one direction against the force of a return spring by a cable movable by an angularly-oscillatable arm carrying an idler sprocket wheel engaging the driving run of the driving chain of a cycle, the arm being biased by spring means in a direction to maintain the driving run of the chain in tension.

By way of example, a variable speed hub gear box for the driven wheel of a bicycle or other pedal cycle is now described with reference to the accompanying drawings, in which:—

Figure 1 is an axial section through the gear box showing the gear box showing the variable ratio drive means in one extreme position;

Figure 2 is a similar view of part of Figure 1 showing the variable ratio drive means in another extreme position;

Figure 3 is a view on the line III—III in Figure 1;

Figure 4 is a view on the line IV—IV in Figure 1; and

Figure 5 is a diagram showing how an operating cable appearing in Figure 1 is moved by the driving chain of the bicycle.

Referring to Figures 1 and 3, the gear box comprises a generally cylindrical tubular housing 1 constituting the hub of the wheel and having annular flanges 2 on which the inner ends of the spokes of the wheel are located. The housing 1 has a closing end plate 3 screw-threaded thereto and mounted for free rotation on a central part-tubular shaft 4. The other end of the housing contains an end collar 5 which is freely rotatable both with respect to the shaft 4 and to the housing 1. The collar 5 has a central spigot 6 on which the driven sprocket 7 (see Figure 5) of the wheel is carried, rotation of the sprocket 7 by the driving chain 31, shown in Figure 5, of the bicycle effecting rotation of the collar 5, which is the aforesaid input or driving member. The collar 5 is fixed to a planet gear carrier 14 co-axial with the housing 1 and carrying a plurality of (e.g., four) planet gears 11 of the epicyclic gear train. The latter also comprises an annular gear 9 carried by the housing 1 and engaging the planet gears 11. The planet gears 11 are supported on shafts 13 extending from the planet gear carrier 14 which is rotatable within the housing 1 and relatively to the shaft 4 about the axis of the latter which is the common axis of the gear box. The epicyclic gear train also includes a sun gear 10 mounted on the

planet gears 11 and the annular gear 9 and the input or driving member 5 driven by the chain sprocket 7 drives the planet gear carrier 14, the annular gear 9 driving the hub 1 of the wheel.

The variable ratio drive means provided by the invention comprises a ring of, for example, four barrel-like members 16 which are mounted in a carrier comprising a ring 17 co-axially rotatably mounted on the sleeve 15 and a plate 18 rotatable on the shaft 4. Each barrel-like member 16 is in the form of a pair of frustums of a cone arranged co-axially of each other with their larger diameter end faces abutting, thereby to form a member which in axial cross-section is of hexagonal shape. The axis of rotation of each member 16 is inclined to the common axis of the shaft 4 and the gear box. The peripheral surface of each member 16 is engaged by an annular follower 20 which is part of the planet gear carrier 14 and an annular follower surface 21 on the sleeve 15. The ring 17, the plate 18 and the members 16 are slidable as a body in the axial direction of the gear box between one extreme position as shown in Figure 1 and another extreme position as shown in Figure 2. In the position shown in Figure 1 the radial distance between the axis of rotation of each member 16 and the follower 20 is less than the radial distance between the axis of rotation of the member 16 and the follower 21. Therefore there will be step-down ratio between the planet gear carrier 14 which drives the members 16 and the sun gear 10 which is driven by the members 16. In the other extreme position of the members 16, as shown in Figure 2, the ratio will be reversed to a step-up drive. In between the two extreme positions of the members 16, there will be a 1:1 drive ratio, where the aforesaid radial distances are equal. The driving of the sun gear 10 by the planet gear carrier 14 through the members 16 will be in the opposite rotational direction and this will modify the rotation of the annular gear 9, and thus the output or driven member 1, being effected directly through the epicyclic gear train. The axial sliding of the members 16 is effected by a cable 19 extending through part of the shaft 4 and which pulls the plate 18 by a disc 22 fixed to the free end of the cable 19. This pushes the ring 17 against a return spring 23 which bears at its other end against the planet gear carrier 14.

The sprocket wheel 7 drives the collar 5 and hence the housing 1 by direct drive through the planet wheels 11. However due to the epicyclic gear train the resultant speed of the housing 1 will be determined by the input/output ratio of the epicyclic gear train. This ratio will be altered depending on the position of the members 16 as described hereinbefore depending upon the movement to the left as viewed in Figure 1, of the cable 19.

Referring now to Figure 5, the cable 19 is pulled by a bell-crank lever 27 pivoted at 28 between the axis of the sprocket 7 and the axis of the pedal sprocket 29. Each arm of the bell-crank lever 27 carries an idler sprocket 30, 31 engaging the driving (upper) and return (lower) runs of the driving chain 31 respectively. The bell-crank lever 27 is biased by a spring 32 into the position in which the driving run of the chain is maintained in tension. Alternatively the bell crank lever 27 may be replaced by a single-arm lever carrying an idler sprocket engaging the driving (upper) run only of the chain 31 and biased by a spring to a position to maintain the driving run in tension, similarly to a de Railleur gear. With either arrangement when torque is applied to the pedal sprocket 29, the driving run of the chain 31 will tend to straighten and this will cause the cable 19 to be pulled to alter the axial position of the members 16 with respect to the sleeve 15 and therefore to alter the ratio of the epicyclic gear train. On reduction of torque on the pedal sprocket 29, the cable 19 will move in the reverse direction and so the members 16 will be moved in the opposite direction axially of the sleeve 15 by the return spring 23, thereby correspondingly altering the ratio of the epicyclic gear train. In this way variations of the torque, i.e., excess torque, applied by the rider to the pedal sprocket 29 will tend to be reduced or the torque applied will tend to become uniform. Although the variable speed gear box described is particularly intended for use in a bicycle, it may have other applications.

CLAIMS

1. A variable speed gear box comprising a rotatable input or driving member; an epicyclic gear train having an annular gear, a sun gear, a plurality of planet gears and a planet gear carrier, of which the planet gear carrier is rotatable about a common axis of the annular and sun gears and is integral with or is attached to the input member and the annular gear is integral with or is attached to an output or driven member rotatable relatively to the input or driving member, a variable ratio drive means acting between the planet gear carrier and a gear of the epicyclic gear train other than a planet gear, and means for adjusting the ratio of the variable ratio drive means between a value greater than unity, through unity, and a value less than unity, thereby to vary the rotational speed of the output member.

2. A gear box as claimed in claim 1 in which the variable ratio drive means acts between the planet gear carrier and the sun gear.

3. A gear box as claimed in claim 2 in which the variable ratio drive means comprises a plurality of barrel-like members arranged in a ring around the common axis of rotation of the epicyclic gear train and each rotatable about an axis inclined to the common axis and bodily slidable along said common axis, the peripheral surfaces of the barrel-like members being engaged by a pair of annular followers carried by the sun gear and the planet gear carrier respectively, whereby rotational drive is effected on rotation of the input or driving member between the planet gear carrier, the follower carrier thereby, the barrel-like members, the follower carried by the sun wheel

depending upon the ratio of the effective distances from said common axis of the points of contact of the respective followers with the barrel-like members according to the instantaneous axial positions of the latter relative to the sun wheel.

4. A gear box as claimed in claim 3 in which the barrel-like members are each in the form of a pair of frustums of a cone arranged co-axially of each other with their larger diameter end faces abutting, thereby to form a member which in axial cross-section is of hexagonal shape.

5. A gear box as claimed in claim 3 or 4 in which the barrel-like members are mounted on a carrier arranged co-axially of the common axis of the epicyclic gear train and which is movable along said common axis by an adjusting member.

6. A variable speed gear box as claimed in claim 5 which is a hub gear box of a pedal cycle, said common axis being the axis of rotation of a driven wheel of the cycle, the input or driving member of the gear box being rotatable by the driven sprocket of the cycle, the output or driven member of the gear box being the housing of the gear box and the hub of the wheel, the common adjusting member being movable axially of the gear box and the wheel in one direction against the force of a return spring by a cable movable by an angularly-oscillatable arm carrying an idler sprocket wheel engaging the driving run of the driving chain of a cycle, the arm being biased by spring means in a direction to maintain the driving run of the chain in tension.

7. A variable speed gear box constructed and arranged substantially as described herein and shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.